Application of Measurements and Modelling in an urban space to improve wellbeing

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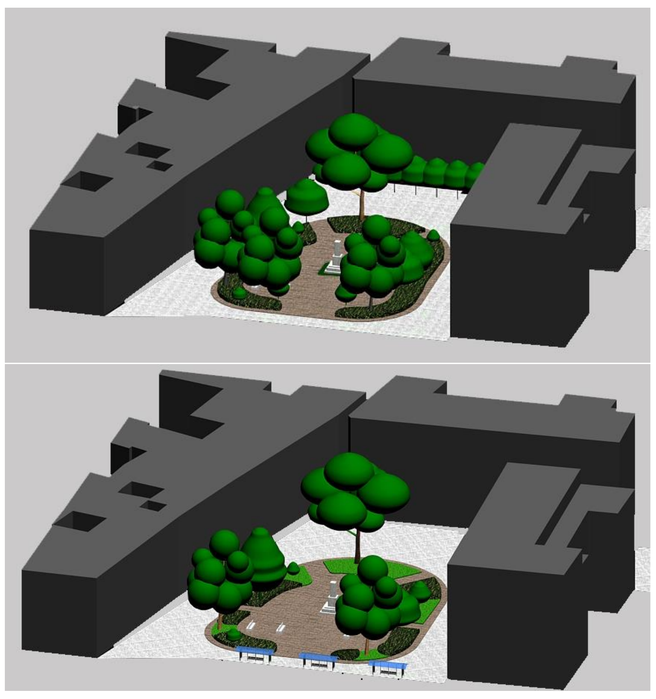


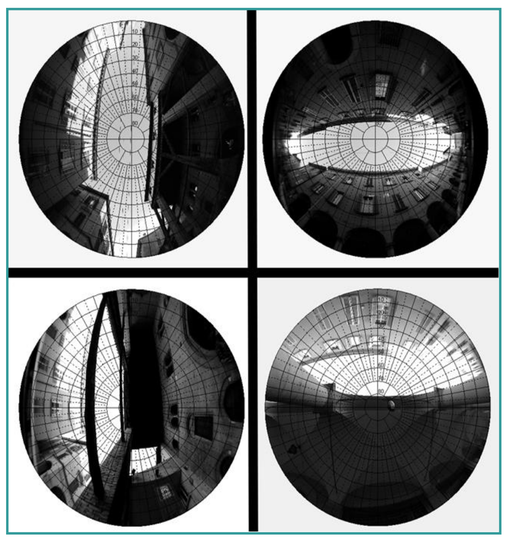
Piazza Minghetti 2007

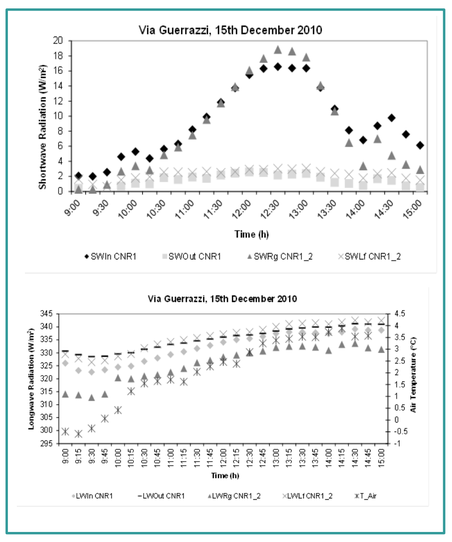
Piazza Minghetti 2013

MEASUREMENTS in URBAN ENVIRONMENT

City Runner

Sensor Name	Measured Variables
Kipp & Zonen CNR1	Long-wave radiation (0.3,50 mm) Short-wave radiation (0.3,3 mm)
Young 21000 Ultrasonic anemometer	3D wind speed and direction, air temperature and turbulence parameters
DustTrak 8520	Optical evaluation of PM 2.5 in terms of mg/m3
VAISALA WXT 510	Air Temp., Relative Humidity, air pressure, wind speed and direction, solar radiation

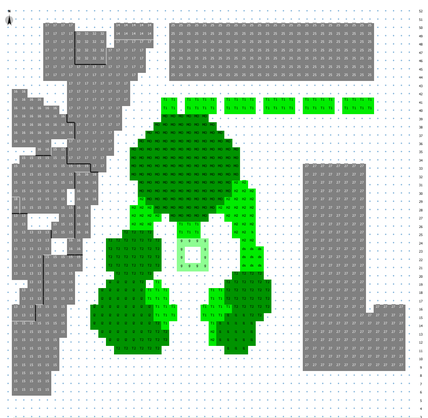




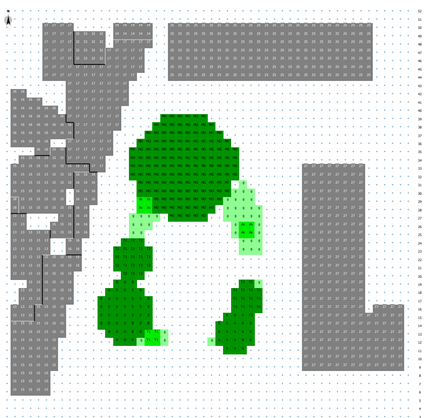
MODELLING in URBAN ENVIRONMENT: ENVI-Met

Architectural modification of existing urban morphology sometimes result as improvements of aesthetic characteristics of open spaces but could produce detriment of pre-exisitng wellness for residential population. An example of ex-ante/ex-post study allows to assess a methodology devoted to planners for the maximization of physiological wellbeing.

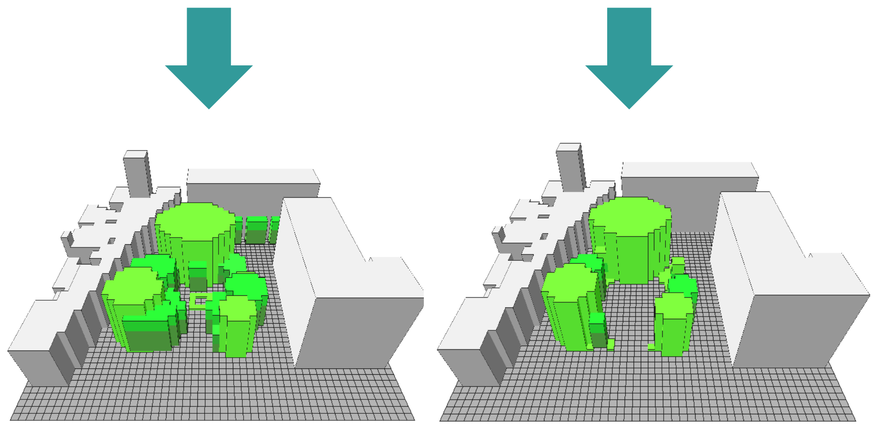
PIAZZA MINGHETTI ENVI-Met SIMULATION



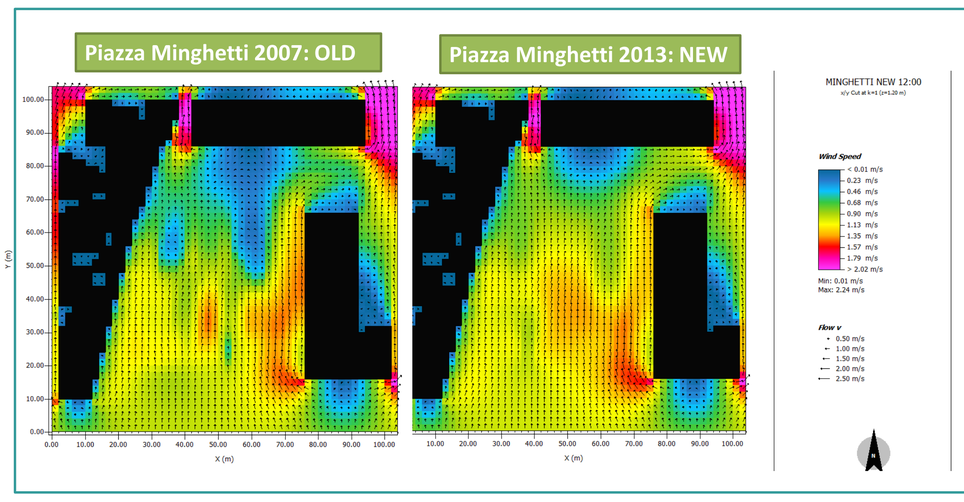
Piazza Minghetti 2007: OLD



Piazza Minghetti 2013: NEW



ENVI-met is a three-dimensional non-hydrostatic microclimate model designed to simulate the surface-plant-air interactions within daily cycles in the urban environment with a typical resolution of 0.5 to 10 m in space and 10 sec in time. Several variables can be simulated, included flow around and between buildings, exchange processes of heat and vapour at the ground surface and at the walls, turbulence exchanges, vegetation parameters, bioclimatology and particle dispersion (http://www.envi-met.com/).
The domain model consisted of a 52 x 52 x 25 grid with a spatial resolution of 2 m x 2 m x 4 m, resulting in a horizontal area of 104 x 104 m^2 with a 100 m vertical extent. The case study reported here focused on the simulation of the summer solstice (June 21). The simulation started at 6:00 a.m. and lasted for 24 hours.

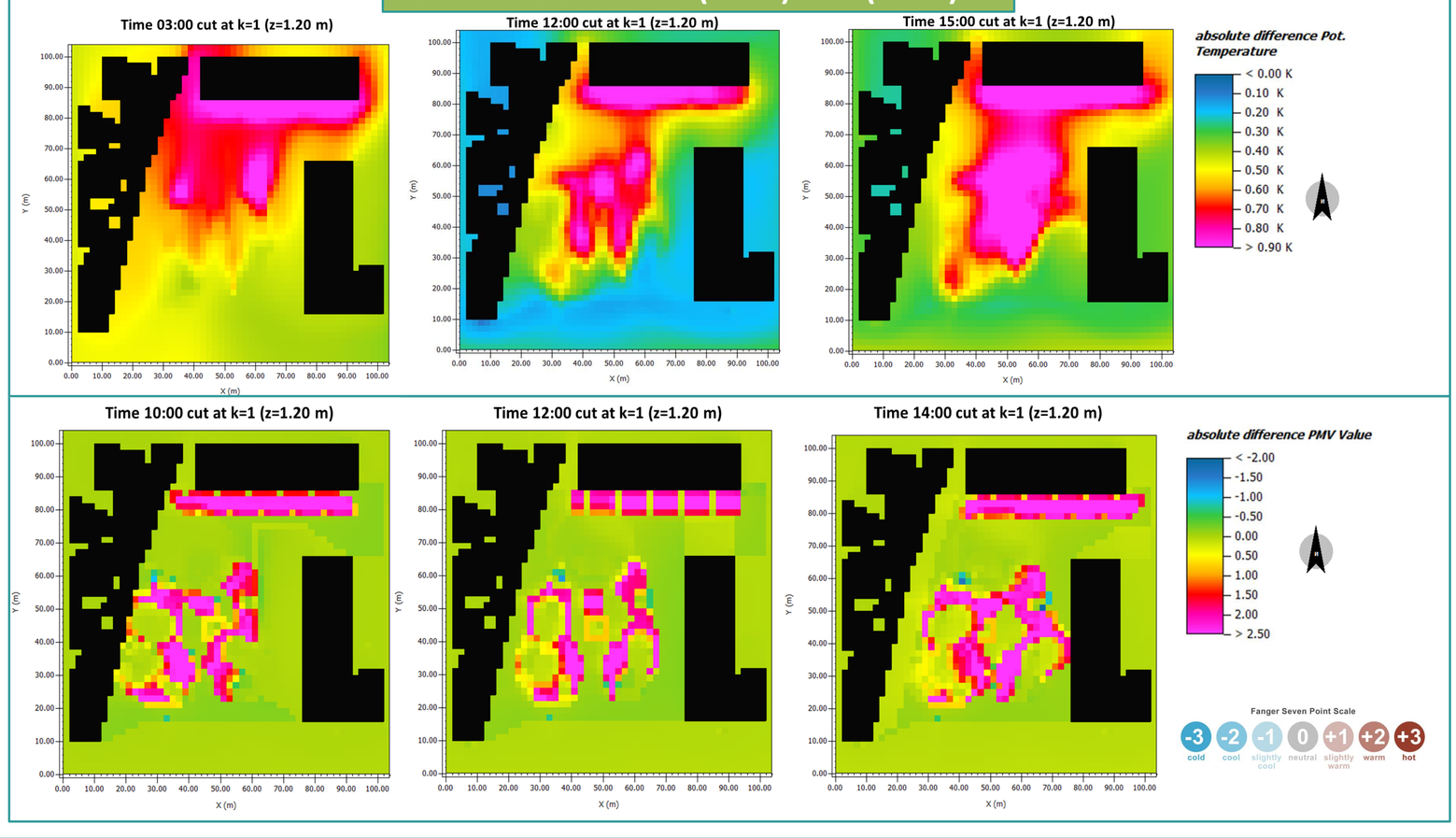


The configuration file contained the atmospheric values: obtained by past measurements conducted in Bologna urban area from the Regional Idrometeorological Service (ARPA-SMR).

- Wind speed and wind direction at 10 m: 1. m s^{-1}, 180 °;
- Surface roughness length (z0): 0.1 m;
- Air temperature: 298.75 K
- Specific humidity at 2500 m: 7 g Water / kg air
- Relative humidity at 2 m: 50%

The results shows a difference in the air potential temperature close to 1 °C in some areas (especially in areas where pavement or concrete have taken the place of flowerbeds and hedges). The predicted mean vote differences reaches value of 2.50 that really shifts the wellbeing for the residential population.
The modernization of Minghetti square shows a worsening of environmental conditions during the summer. The methodology proposed here can be used in future reorganization of common urban spaces .

COMPARISON: NEW (2013)-OLD(2007)



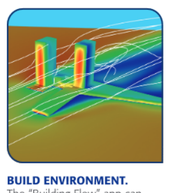
MODELLING in URBAN ENVIRONMENT: KARALIT

TECHNOLOGIES
- Immersed Boundary Technique
- Anisotropic LGR (Local Grid Refinement)
- Implicit: steady state & transient (Dual Time Stepping)
- Explicit: steady state & transient (constant time step)
- Preconditioning
- Massively Parallel MPI (efficient parallel processing on shared memory environment or cluster)
- Thin surfaces (sails, parachutes, fins)
- incompressible.
- All range of Reynolds, Mach and Grashof numbers
- Heat Transfer: thermal conduction, forced & natural convection (buoyancy)
- Turbulence models: Spalart-Allmaras, κ-ω, κ-g
- Porous surfaces and volumes
- Volume sources: heat, momentum, pressure gradient
- Diabatic heat transfer model through solid walls
- Single reference frame rotating flows
- wall roughness, moving & rotating walls
- Atmospheric boundary layer
- Symmetry
- Inlet/Outlet: velocity, pressure, mass flow rate
- Periodic translation & rotation

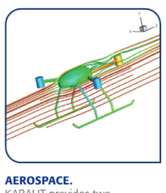
USER INTERFACE
- Application-driven interface:
- Dedicated Apps: External Aerodynamics, Wind Tunnel, Building flow, Environmental Terrain flow, Internal flow, FreeApp

PRE PROCESSING
- Import STL and MAP formats
- Geometry STL manipulation: rotation, scaling, translation
- Complex objects composition
- Void volumes (VOID)

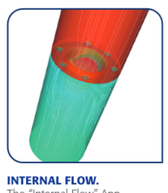
POST PROCESSING
- KARALIT Visualizer
- Export to Paraview, Tecplot 360, Ensight
- App-customized monitor: forces, heat transfer, mass flow rate, pressure



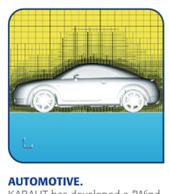
BUILD ENVIRONMENT.
The "Building Flow" app can be used for build environment applications such as pedestrian comfort analysis outside of buildings and on walkways, smoke dispersal and fire safety; it can also be used for energy efficiency inside buildings, analysis of wind forces on building walls, antennas. Another app, named "Environmental Terrain Flow", has been designed to perform a wind site assessment study. The app reads directly the .map file (x,y,x, terrain roughness) to verify the proper wind speed distribution within a specified site. As for all KARALIT apps, the simulation is carried out by simply setting up few parameters.



AEROSPACE.
KARALIT provides two apps for aerospace external aerodynamic simulations: an External Flow App and a Wind Tunnel App. Both customized apps walk the user through the necessary inputs to set up boundary conditions, flow regime and other parameters. Within minutes, even CFD novices can begin running high-quality simulations.



INTERNAL FLOW.
The "Internal Flow" App, drastically simplifies the setup of complex geometries from automotive, aerospace, Oil&Gas, medical and other sectors. Users work directly on their CAD geometry and, through the App, enter a few key inputs - such as the boundary conditions, fluid properties and flow regime, going from CAD to simulation in a few minutes.

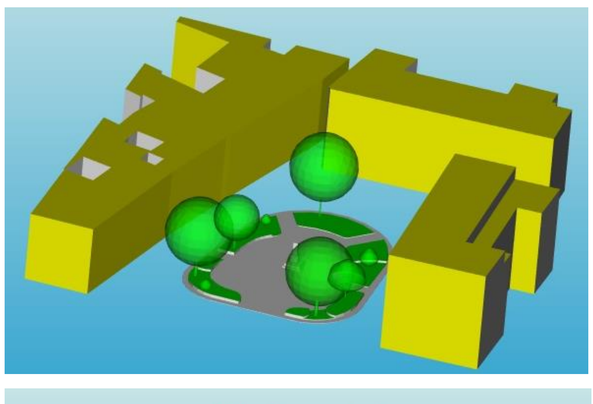


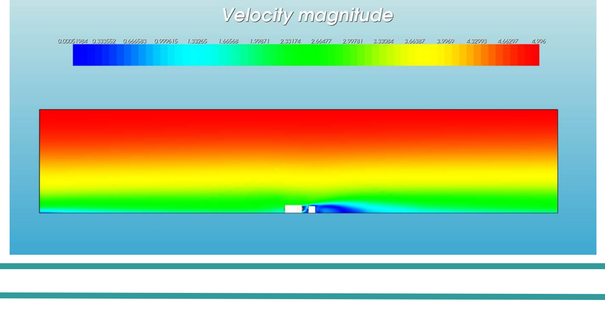
AUTOMOTIVE.
KARALIT has developed a "Wind Tunnel" app, to help designers and CFD analysts during the aerodynamic study of the car. The app can be used for studies of factors such as airflow around car bodies, pressure distribution, turbulence and drag. Users simply enter the parameters for key factors and the app takes over, setting up the boundary conditions for a highly accurate simulation.

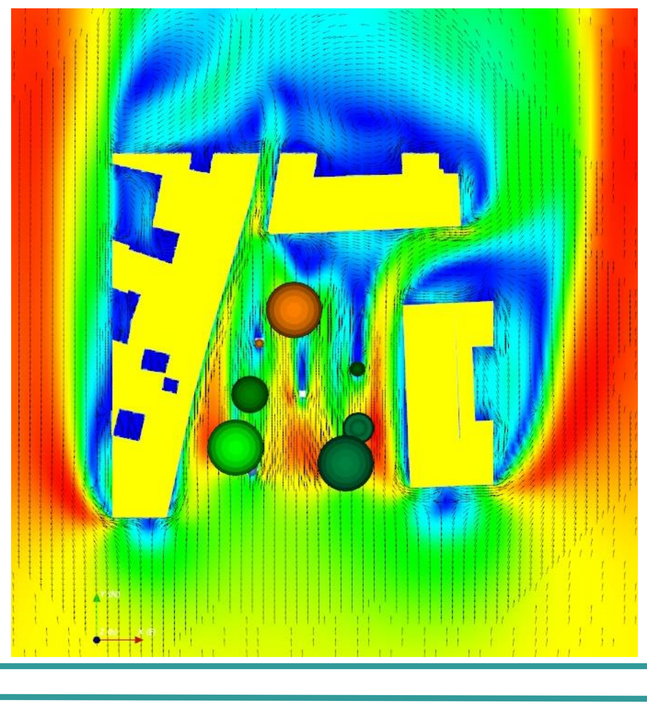
SYSTEM REQUIREMENTS KARALIT CFD 2.1
- Windows® 7 64-bit or superior
- Fedora™ 15 or superior
- Ubuntu 11.04 or superior
- Red Hat
- SuSe
- Intel® Pentium® 4, Intel Xeon®, Intel Core™, AMD Athlon™ II, AMD Opteron™, AMD Phenom™, AMD FX™ processor or later (2 GHz CPU speed or higher)*
- 8 GB RAM or higher**
- 10 GB or higher of free disk space (500 MB free disk space for installation)
- 512 MB DRAM or higher OpenGL-capable graphics card
- 24-bit color setting at 1,280 x 1,024 or higher screen resolution
- CD-ROM and DVD-ROM drives are not required: installation via electronic download
- Web browser
- Internet connection for web downloads

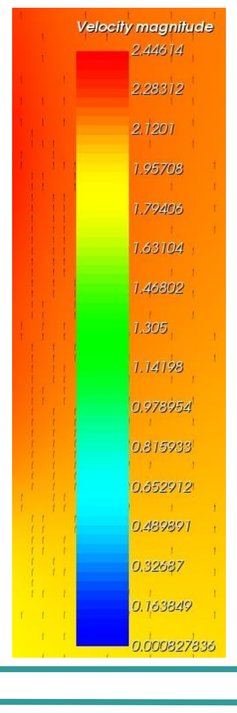
Notes
** For superior performance, KARALIT recommends an Intel Xeon®, or AMD Opteron™ processor, and 24 GB RAM or higher.*

*** KARALIT recommends settings that allow your operating system to manage virtual memory, as needed. There should always be at least as much free hard disk space as system memory (RAM).*









KARALIT CFD simulation results of the Minghetti square.

Section at z=1.5 m of the wind magnitude and wind direction.

KARALIT
Simplicity without compromise

KARALIT CFD is a Navier-Stokes code based on the Immersed Boundary (IB) technology that reduces meshing time, the most time consuming activity in CFD analysis, by 99%. KARALIT calls this innovation Direct CFD: CAD models go directly to CFD without time-consuming meshing or tedious manual set-up. The simple process streamlines CAD-to-CFD for experts and non-specialists alike.

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